Don Norman

The Design of Everyday Things

(2013; revised and expanded edition)

overview of core concepts

What are we doing here?

- Don Norman's classic book: *The Design of Everyday Things*
  - A must read for designers, user experience professionals, and anyone interested in how people interact with products
  - Simple language with illustrative examples
- However: the book relies on a lot of oversimplification
  - Some scientific accuracy is lost
  - Some interesting context is not discussed (e.g., Gibson's perception-action cycle or activity theory)
- This slide deck summarizes and explains basic terminology with some extra context

affordances and signifiers

Affordances: Don Norman

- Relationship between a physical object and a person (or any other interacting agent) → two-sided
- Relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used
- Affordances determine what actions are possible

- But: affordances are often learned
  - Through instruction
  - Through interaction

Affordances: exercise bicycle

appearing health-conscious
to friends and neighbors

exercising

pretending to exercise
(sitting on bicycle and watching TV)

hanging clothes

drying curtains

hiding things
from small children

Affordances: Bill Gaver

Gaver, W. (1991). Technology affordances. *Proceedings of the SIGCHI conference on Human factors in computing systems Reaching through technology - CHI '91*. pp. 79-84. https://doi.org/10.1145/108844.108856

- Classifying affordances based on their visibility to the user

- Correct rejection: no perceptual information, no affordance
- Perceptible affordance: obvious perceptual characteristics of the object itself indicate what action possibilities are available and desired
  - Example: a door handle
- Hidden affordance: affordance exists, but it is not easily perceived; users often must rely on experience and/or trial and error to determine possible actions
  - Example: hover/click on suspected drop-down menus
- False affordance: an object's characteristics suggest users can do something they can't
  - Example: underlined text that isn't a link

Affordances: Rex Hartson

Hartson, R. (2003). Cognitive, physical, sensory, and functional affordances in interaction design. *Behaviour & Information Technology, 22*(5), 315-338. https://doi.org/10.1080/01449290310001592587

- Classifying affordances based on the interaction mode

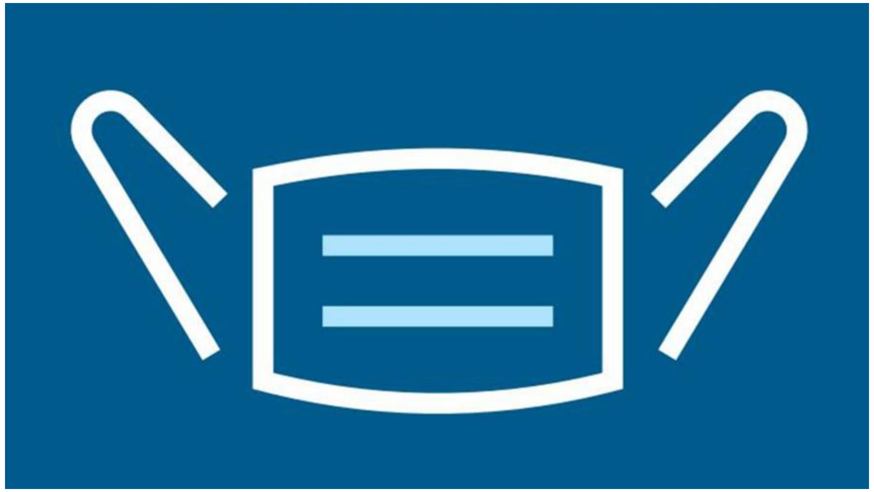
- Cognitive affordance: helps user in knowing something
  - Example: a button label indicating what happens when user clicks on it
- Physical affordance: helps user perform a physical action
  - Example: a button large enough so that users can click on it
- Sensory affordance: helps user sense or perceive something
  - Example: a button label in font size big enough for users to read it
- Functional affordance: helps user accomplish work
  - Example: a "sort alphabetically" function triggered by clicking the button

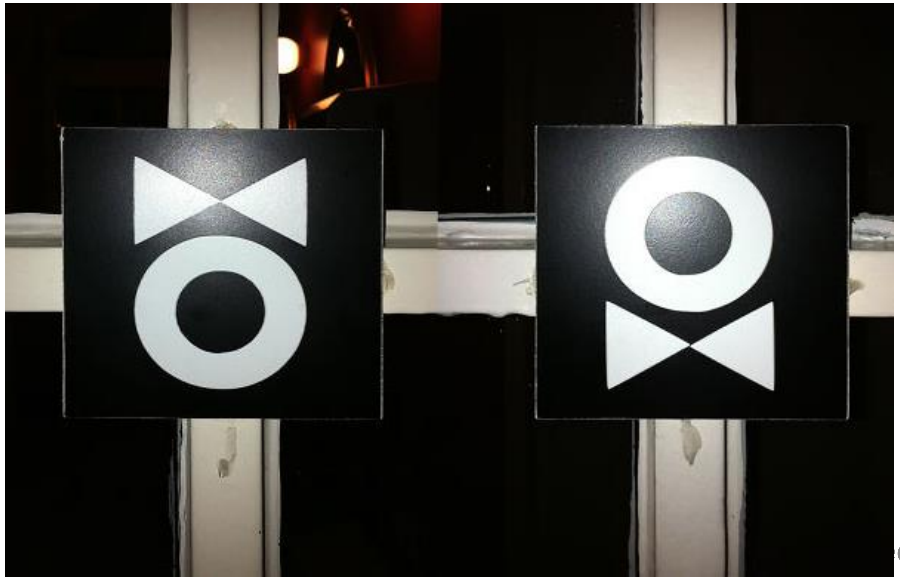
Signifiers: Don Norman

Norman, D. A. (2008). THE WAY I SEE IT Signifiers, not affordances. *Interactions*, 15(6), 18-19.

- Any mark or sound, any perceivable indicator that communicates appropriate behavior to a person → a communication device
- Some sort of a signal in the physical or social world that can be interpreted meaningfully
    - signifiers indicate critical information, even if the signifier itself is an accidental byproduct of the world
- Signaling *components* of affordances

Deliberate signifiers





https://www.boredpanda.com/funny-bathroom-signs/

Image by freepik (https://www.freepik.com/)

Accidental signifiers

Norman, D. A. (2008). THE WAY I SEE IT Signifiers, not affordances. *Interactions*, 15(6), 18-19.

Image by freepik (https://www.freepik.com/)

Affordances and/or/versus signifiers

- Affordances are possibilities in the world about how an agent can interact with something
- Signifiers are instructions in the world for how a thing is meant to be used (and where that action should take place)

hiding things
from small children

exercising

pretending to exercise

hanging clothes

drying clothes

appearing health-conscious

...etc

What if we think about affordances and signifiers in terms of probability?

What is the likelihood that someone will act on a specific affordance or signifier?

Can this probability be increased/decreased?

Discoverability & understanding

- Discoverability: is it possible to figure out what actions are possible, and where and how to perform them?
  - Relevant components must be visible
  - Visible components must convey the correct message on what actions are possible, and how they should be performed
- Understanding: what does it all mean? How is this product supposed to be used? What do all the different controls and settings mean?

- Not always intuitive – more complex devices require the aid of manuals or personal instructions
  - In principle, no manual should be necessary to understand how to use simpler objects

mapping, feedback, and models

Mapping

- The relationship between actions and consequences
  - Important: mapping is easiest to learn when there is an understandable link between the controls, the actions, and the intended result
- Typically relevant to the layout of controls and displays
- Mappings can be cultural or perceptual
  - Example: is volume controlled left/right or up/down?

Feedback

- Communicating results of action, so you know the system is working as intended and your action upon that system has consequences.

Conceptual models

- A highly simplified explanation of how something works
  - If we have an idea how something should work, then we can predict some affordances

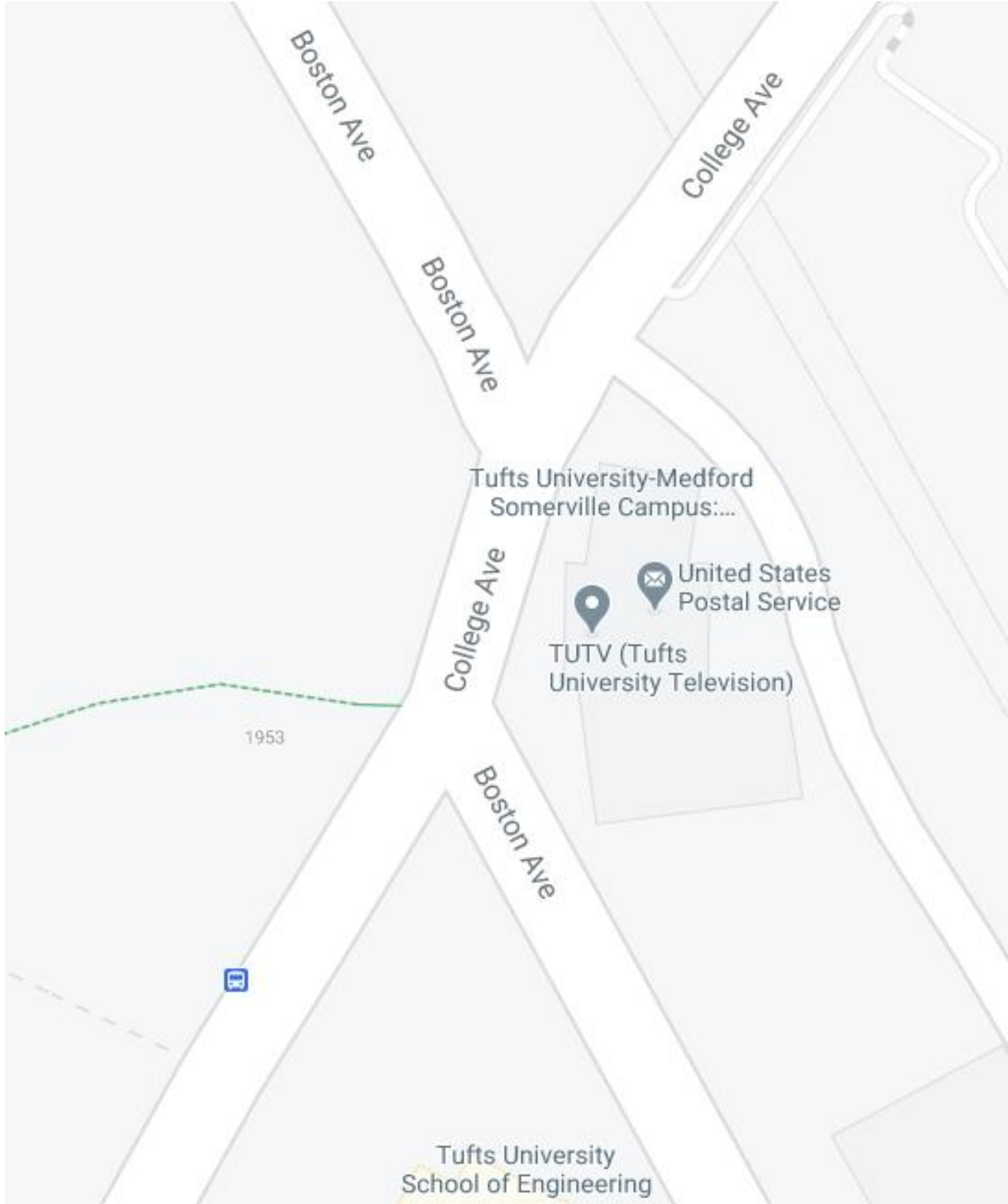
- Doesn’t have to be complete or even accurate – but must be useful

- How do we produce a reliable conceptual model?
- How do we assess if the conceptual model is reliable?

Mental models

Johnson-Laird, P.N. (1980). Mental models in cognitive science. *Cognitive Science, 4,* 71-115.

- Representations of something (physical or not) in the mind; internal model of the world
  - A hypothetical internal cognitive symbol that represents external reality, or a mental process that makes use of such symbol
  - Mental representations do not have to be detailed or accurate to be useful
    - In fact, they tend to be biased and oversimplified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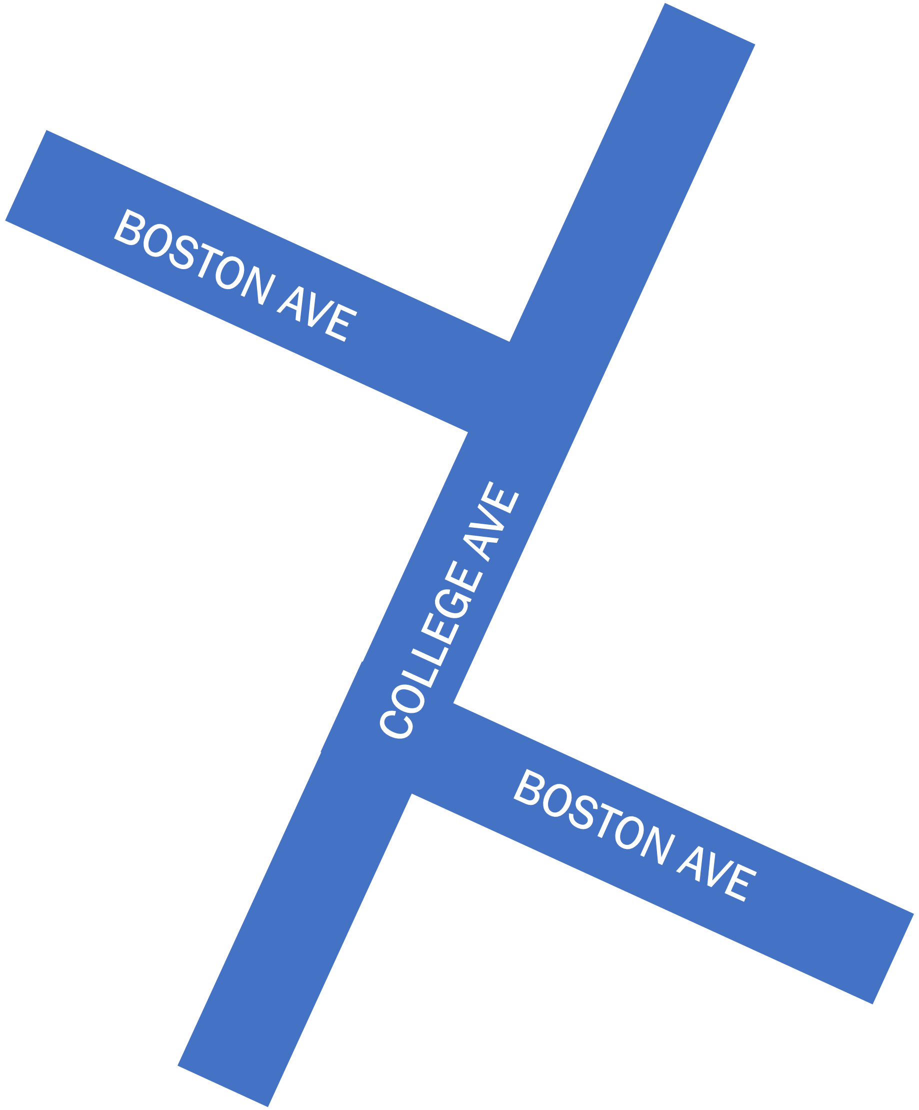
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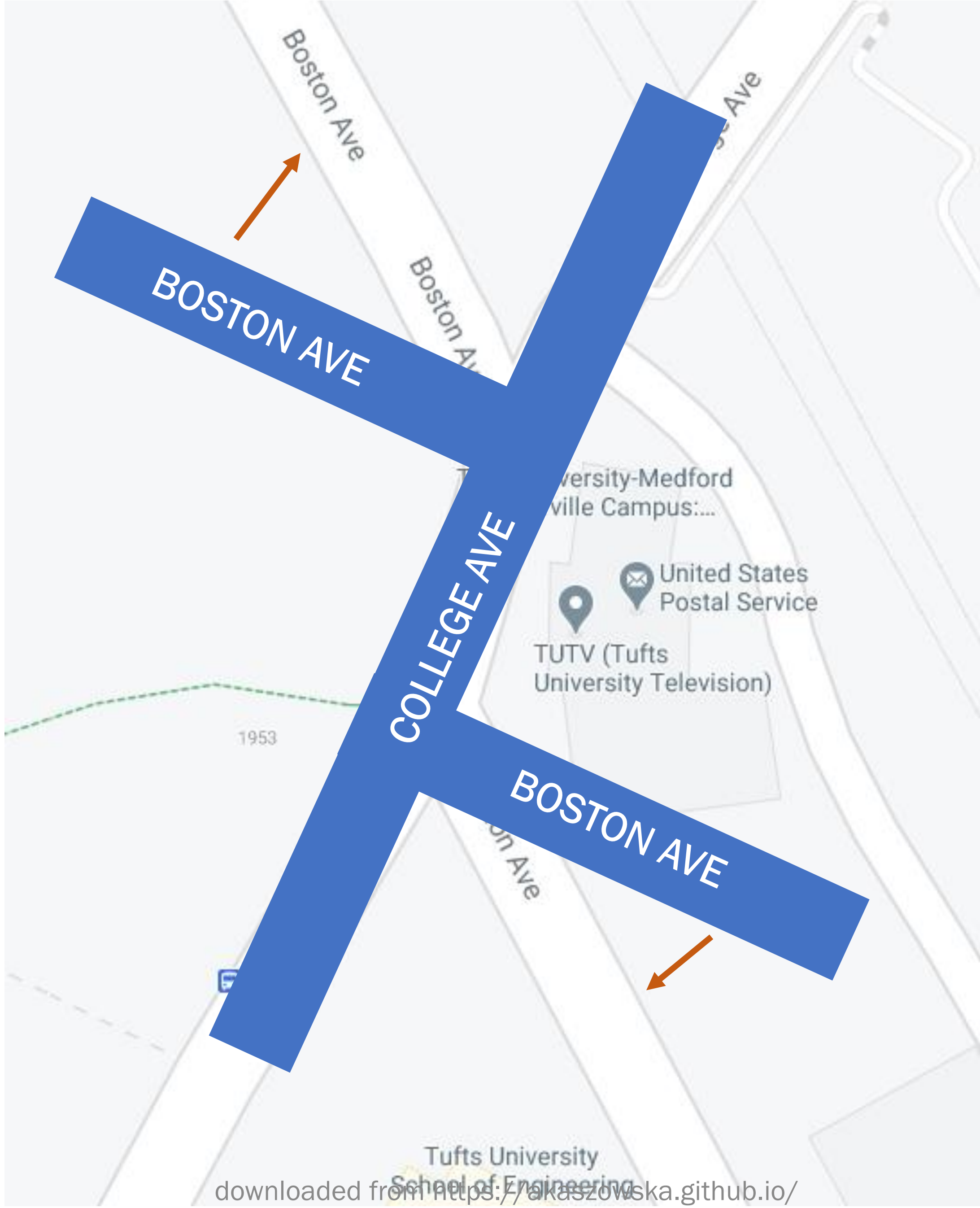
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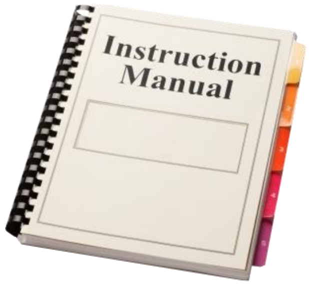
How do we identify mental models?

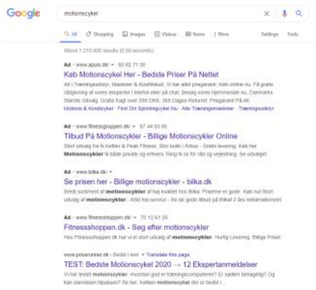
- Subjective reports?
  - What about validity of subjective self-reports?
- “Objective” cognition?

- Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*(3), 231–259.
- Zell, E., & Krizan, Z. (2014). Do People Have Insight Into Their Abilities? A Metasynthesis. *Perspectives on Psychological Science: A Journal of the Association for Psychological Science, 9*(2), 111–125.

The system image

- Combined information on the system that is available to the user
  - Physical structure of the object, information available in documentation, instructions, signifiers, product reviews on the internet, help websites, information forums…

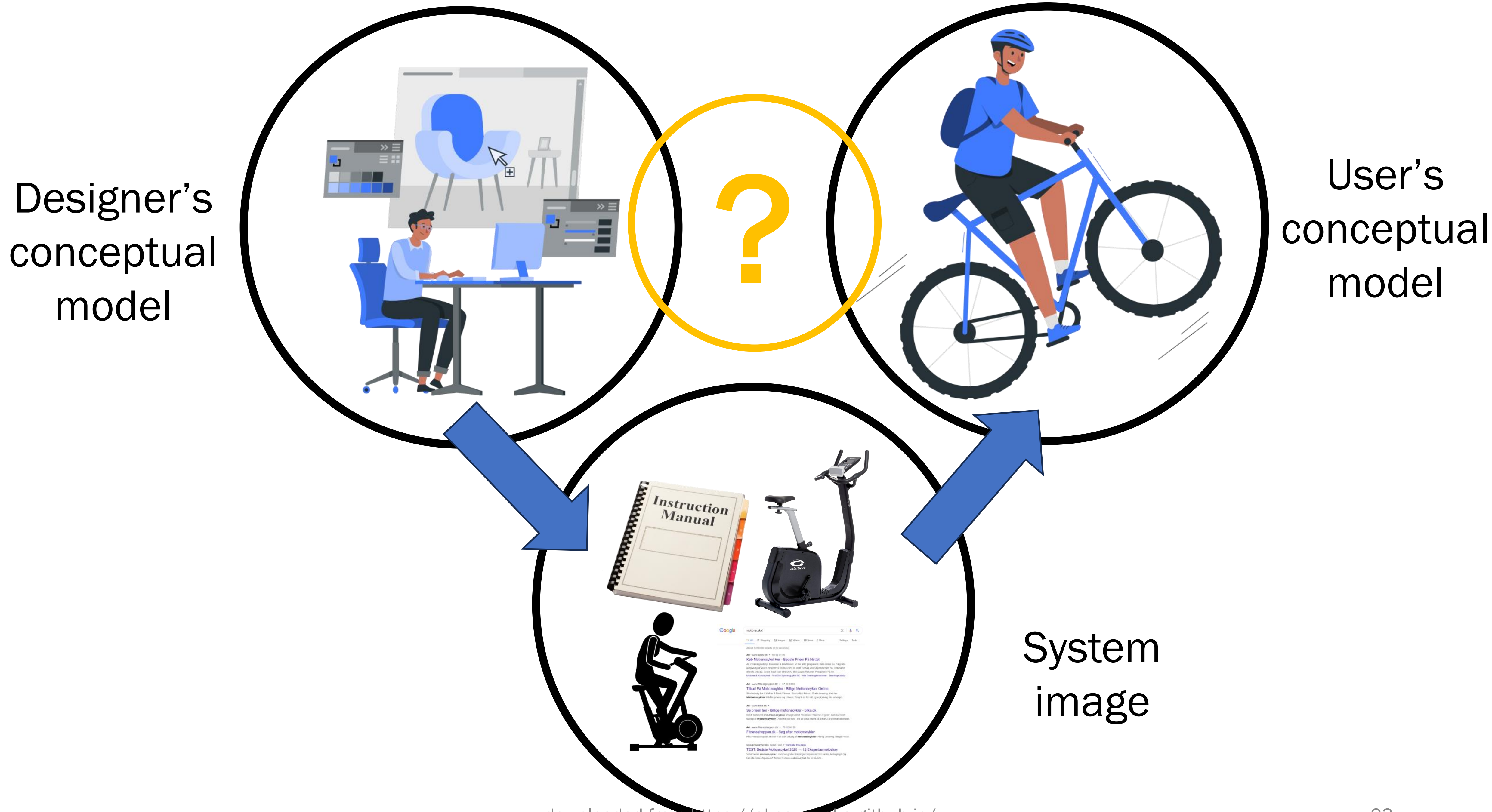




Conceptual models

- Designer's conceptual model comes from, well… actually designing the product
- User's conceptual model comes from the system image through interaction with the product, reading, googling, asking friends, etc.

- Most optimal usage of product is when the designer's conceptual model to be identical to the user's conceptual model



Illustrations by Storyset (https://storyset.com/) | Figure redrawn from Don Norman's *Design of Everyday Things*

How do you optimize the system image?

Don Norman says: communication and good design!

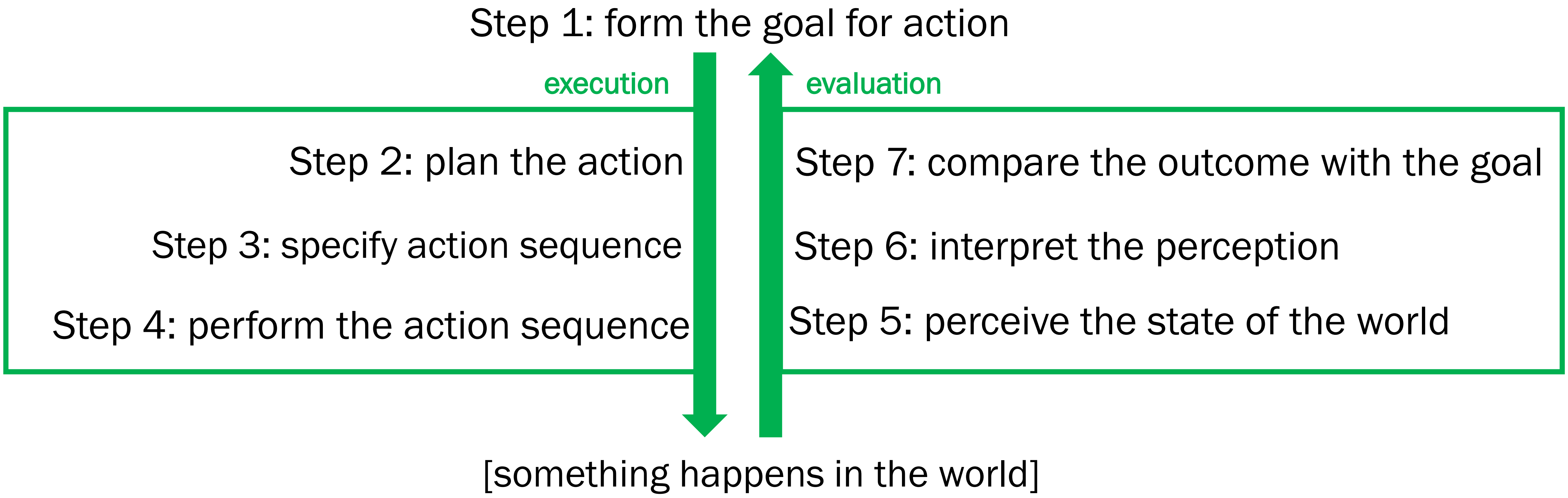
Gulfs of execution and evaluation

- Gulf of Execution: the difference between the intentions/goals of the users, and what the system allows them to do

- Gulf of Evaluation: the difficulty of assessing the state of the system, and how well the system supports the discovery and interpretation of that state

- How to we bridge the two gulfs?

Norman’s stages of action and processing



a lot of Norman’s work is rooted in/related to ecological psychology and activity theory

James J. Gibson (1904 – 1979)

Gibson’s background

- Served in the American Air Force in WW2; developed screening tests and training protocols for airplane pilots
- Starting point to his research: the three-dimensional structure of the visual world, perceived by <u>real observers</u> engaged in <u>specific tasks</u>
  - The human visual system is designed in such a way that we don’t need to build any internal representations of the world → it is enough to just look around in real time
  - Laboratory experiments are highly unrealistic setups, and therefore their results do not help us understand perception and action in the real world

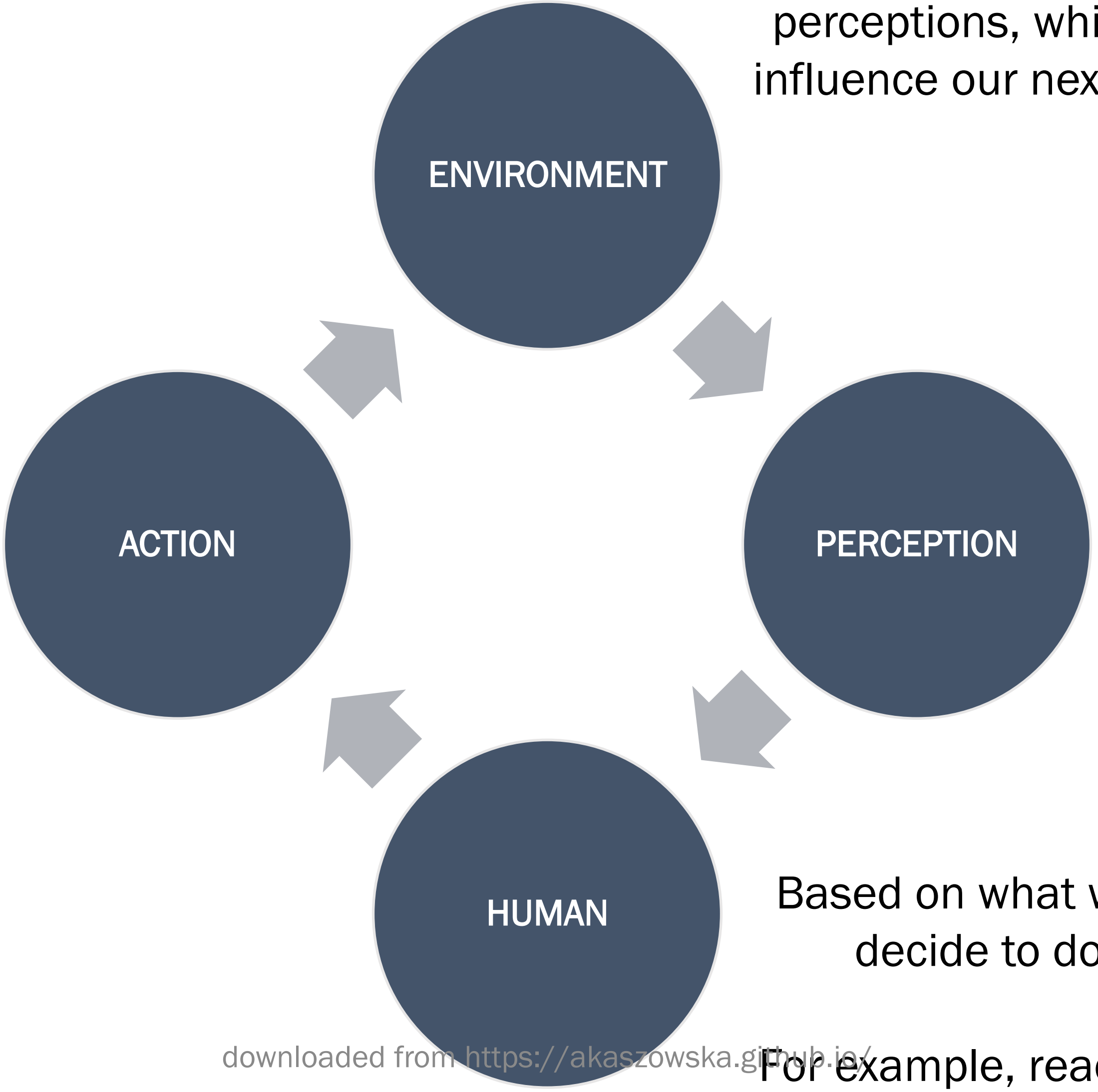
Gibson's influence

Bruce, V., & Tadmor, Y. (2015). Perception: Beyond Gibson's (1950) direct perception. In M. W. Eysenck & D. Groome (Eds.), *Cognitive psychology: Revisiting the classic studies* (pp. 24-37). Thousand Oaks, CA: SAGE.

- Ecological validity of research
  - Understanding the limited character of most research on perception, including visual perception
  - Shift towards using natural scenes (or virtual renderings of natural scenes) and natural tasks
- Introducing affordances as a concept
  - an important theoretical resource that found many practical applications, including applications in the field of design (largely through Don Norman)
- Defining the sensory systems as:
  - coupled with action systems
  - evolutionarily adapted to the (informational) structure of environment

Perception-action cycle

This feedback leads to new perceptions, which then influence our next actions



We take in information from our environment using our senses: seeing, hearing, or touching

Based on what we perceive, we decide to do something

For example, reach out for a mug

After we act, we get feedback from the environment

For example, mug is hot

knowledge in the head
vs. knowledge in the world

Main take-home message

The most effective way of helping people remember is to make it unnecessary.

Norman, 2013, p. 100

Putting memory in the world

- Knowledge is not all in the head[1]; it is partially in the world, and in the constraints of the world → we continuosly perceive information from the world, and that information guides our actions and behaviors
- Precise behavior can result from imprecise knowledge for four reasons:
  - Information is in the world
  - Precision is not required for many tasks
  - Natural constraints are present
  - Cultural constraints are present

[1] what about knowledge "in the body"? – "head" assumes conscious recall of information

Information in the world

Is Elsa's dress more blue or more green?

Via Disney

Via Disney

And finally, which is the correct shade of green for Mike Wakowski's skin?

Via Disney

Via Disney

Screenshots and examples from https://buzzfeed.com/

Information is in the world

- Information coded in memory only has to be precise *enough* to sustain required quality of behavior
  - If I can't remember something, and this information is important for certain tasks, I can put reminders in the world → writing computer/email password on a sticky note and keeping it on their monitor
- If information needed to do a task is readily available, then there is less need for us to learn it
  - This has some implications for how we test and examine students: open-book tests vs. memory tests → what are we actually testing there? Why?

Precision is not required

- Don’t need all information in head; just *enough* to complete a task
- Can distinguish between different coins, although may not be able to tell you what is on each coin, or the words on the coins
- But if you make more precise memory necessary, you will have a problem → because precise memory is difficult to maintain

Sometimes precision is required

Image from https://www.reddit.com/r/CrappyDesign/comments/3s4dds/this_seems_like_a_bad_idea/

My red notebook

- How much precision do I need?
- I buy a red notebook
  - What do I call it?
- Then I get a second notebook--a blue one
  - What do I call my first notebook?
- Then I get a small red notebook
  - Now what do I call my first notebook?
- Mental representations need only discriminate among choices in front of me
- But add another choice and I have to change my representation – make it more *precise*

Image by freepik (https://www.freepik.com/)

Natural constraints

- Often an object’s physical features limit how it can be used
  - Example: how do you *most successfully* signal to people that they should not use a specific entrance?
- Natural constraints are present and limit the range of allowed actions: we do not live in a random world
  - Can’t use a spoon to brush teeth
  - Can’t use a rock to make a phone call

Cultural constraints

- Society has evolved many conventions that govern acceptable social behavior
  - This lets us know what to do in unfamiliar circumstances
- What is appropriate behavior at a party, or in a restaurant?
  - What is the sequence of events in a restaurant?
  - When does the bill arrive?
    - In Europe: the customer asks for the bill when they are ready to leave
    - In USA: the waiter brings the bill when the customer is finished with their food

So what is it?

- Knowledge in the world:
  - perceived affordances and signifiers, the mapping between the parts that appear to be controls or places to manipulate and the resulting actions, the physical constraints that limit what can be done
- Knowledge in the head:
  - conceptual models; cultural, semantic, and logical constraints on behavior; and analogies between the current situation and previous experiences with other situations

Knowledge in the head

- Physical constraints: possible interactions with a product
  - Legacy problem: e.g., iPhone chargers, headphone jacks
- Cultural constraints: what other people tend to do
  - Conventions
    - Violation of convention has detrimental consequences to trust (e.g., at a workplace)
    - Handshakes? Hugging? Blinking your car's emergency lights: thank you or fuck you?
- Semantic constraints: meaning of situation controls sets of possible actions
- Logical constraints: deduction or inference

- Device-centered controls vs. activity-centered controls
  - Norman's example of lecture hall lighting, p. 140
- Constraints allow us to go from perception of an affordance to understanding of potential action

Tradeoffs between Knowledge in the World and in the Head (1)

- We need both knowledge in the world and in the head
- But in certain situations, we choose to rely more on one than the other
- Gaining the advantages of knowledge in the world means losing the advantages of knowledge in the head

Tradeoffs between Knowledge in the World and in the Head (2)

- We can put information in the world…
  - Provide the pilot with CDTI (cockpit display of traffic information)
  - Stick *Post-It* notes around my computer display
  - Show continuous record of location in a hierarchical menu structure
- …but it causes visual clutter, might disrupt performance of pilot or user
  - With CDTIs may increase the visual workload--is the increase worth the benefits?
- Memory aids (information in the world) are a mixed blessing: they help us function without remembering things, but then they make remembering unnecessary, so… we don’t remember things
  - Does using GPS prevent us from learning the layout of the environment?

Extended mind (1)

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis, 58*(1), 7–19.

- Thesis: some objects in the environment can be part of a cognitive processes, and thus they are extensions of *the mind itself*
  - Objects that store information (knowledge in the world?)
  - A “thinking system” is characterized by the functional: which elements are reliably included in the thinking.

Extended mind (2)

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis, 58*(1), 7–19.

- The parity principle:
  - If, as we confront some task, a part of the world functions as a process which, were it to go on in the head, we would have no hesitation in accepting as part of the cognitive process, then that part of the world is (for that time) part of the cognitive process.
  - If an external tool (or part of the environment) helps us think, that tool becomes part of our cognitive process: thinking therefore happens not only in the brain, but in the environment as well.

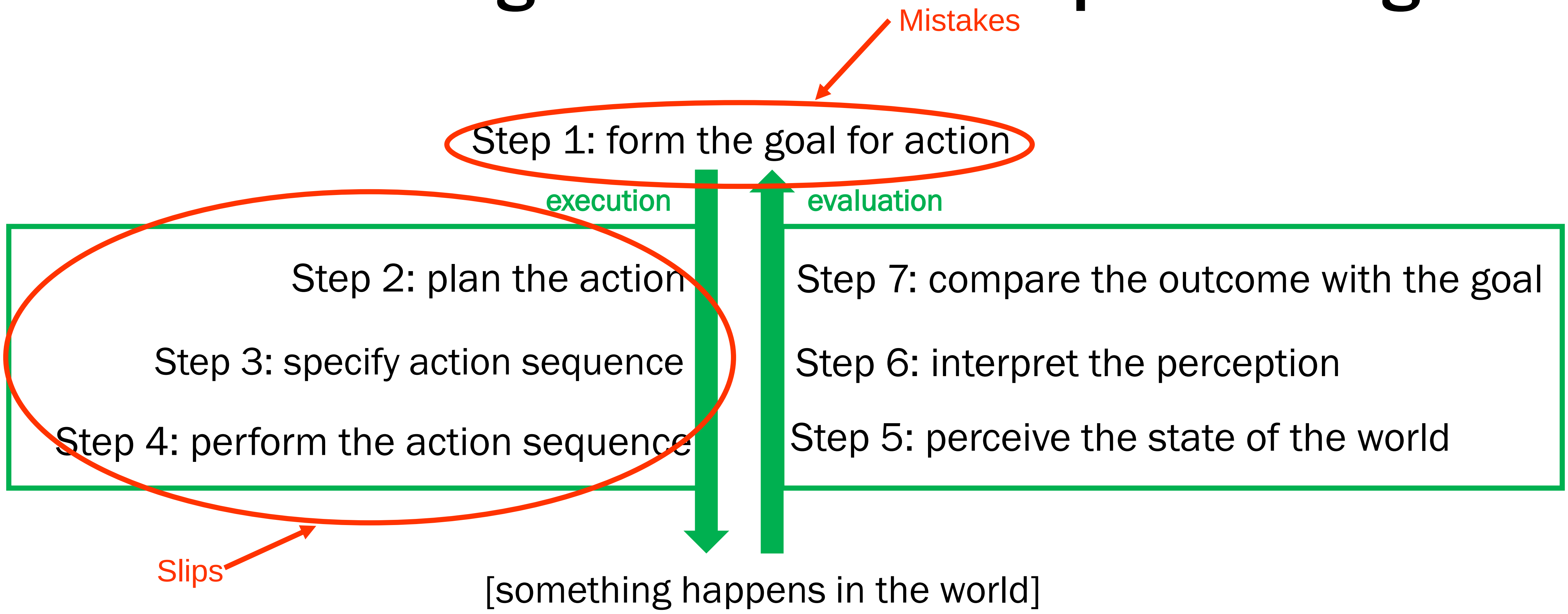
errors

Norman’s error classification

- Action-based
- Memory-lapse

- Rule-based
- Knowledge-based
- Memory-lapse

Norman's stages of action and processing



Slips (1)

- The user intends to do one action, and ends up doing something else → performance error → most common in skill-based behaviors
- Paradoxically, more frequently done by skilled people than novices
  - Slips are attention fails, and experts perform tasks automatically, so they're more likely to slip → we don't tend to make slips while learning

Slips (2)

- Action-based slips: wrong action is performed
  - Capture slips: a situation where instead of desired activity, a more frequently or recently performed activity gets done
  - Description-similarity slips: vague description of target leads to users acting upon an item *similar* to the target
  - Mode errors: device has different states in which the same controls have different meanings

Slips (3)

- Memory-fails → Main cause: interruptions!
  - the action is not done at all;
  - failing to do any steps of a procedure;
  - repeating steps;
  - forgetting an outcome of an action;
  - forgetting the goal or plan (therefore stopping action performance altogether)

- Also see: Norman, D. A. (1981). Categorization of action slips. *Psychological Review, 88,* 1-15.

Mistakes (1)

- The user establishes the wrong goal, or the wrong plan is formed → planning error
- Rule-based mistakes: correct situational diagnosis (problem state analysis), but erroneous course of action chosen
  - The situation is mistakenly interpreted: wrong goal/plan invoked
  - The correct rule/plan is invoked, but the rule itself is faulty: improper rule formulation, wrong assessment of problem space
  - The correct rule is invoked, but the outcome is incorrectly evaluated: and the error cycle continues

Mistakes (2)

- Knowledge-based mistake: problem is misdiagnosed due to erroneous or incomplete knowledge
- Memory-lapse: forgetting happens at the stage of goal, plan, or evaluation

Designing for Mistakes and Slips

- Understand causes of error and design to minimize them
- Allow reversible actions
  - Make it possible to reverse actions (to “undo” them) or make it harder to do what cannot be reversed
- Make errors easy to detect
  - Make it easier to discover errors that do occur, make them easier to correct
- Expect errors
  - People will make them

Example: Forcing function

- Prevents the user from taking an action without consciously considering information relevant to that action
- It forces conscious attention upon something ("bringing to consciousness") and thus deliberately disrupts the efficient or automatized performance of a task
- Three kinds of specialized methods for forcing functions:
  - Interlocks
  - Lockins
  - Lockouts

Interlock

- Two mechanisms or functions are mutually dependent
- Forces operations to take place in proper sequence
- Example: microwave oven door opens, power turns off

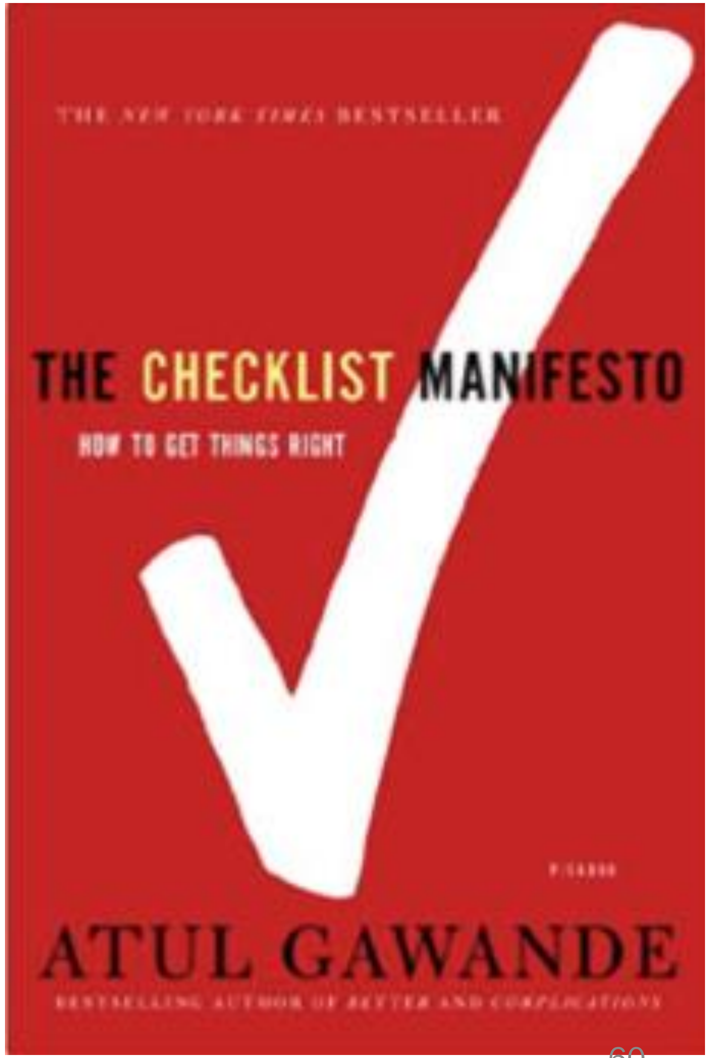
Image by upklyak on Freepik (https://www.freepik.com/)

Lockout

- Prevents event from occurring
- Example: put up a gate so people know they are going from ground level to basement
  - Without gate, people don’t realize they have reached ground floor in emergency (e.g., fire)
  - If ground floor status emphasized (e.g., different paint color, higher ceilings, different type of exit door) may not need lockout

Memory slips&mistakes: checklist manifesto

- Errors of ignorance: mistakes we make because we don't know enough
- Errors of ineptitude: mistakes we make because we don't make proper use of what we know
- Modern world is so complex that we are bound to make both kinds of mistakes, but errors of ineptitude can be corrected for by a neat and handy checklist:
  - Experts need checklists–literally–written guides that walk them through the key steps in any complex procedure



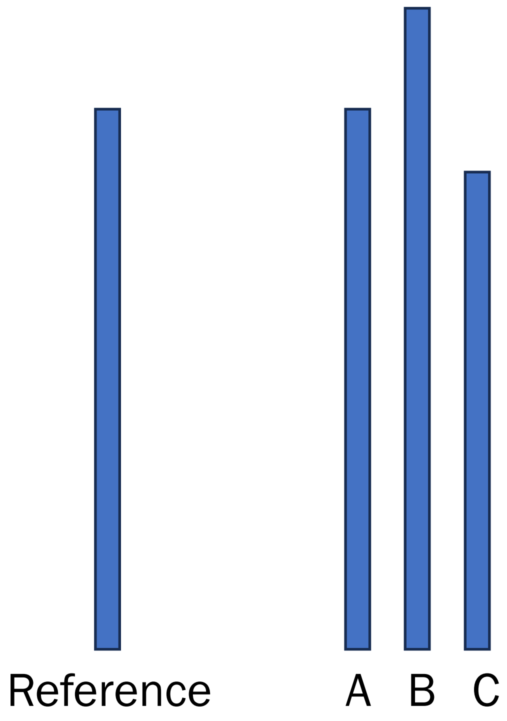
http://atulgawande.com/book/the-checklist-manifesto/

Example: surgical “time out”

- The universal protocol
- Time-out: the procedure is not started until all questions or concerns are resolved
  - Perform immediately before starting the procedure
  - Identify all relevant members of the team are present
  - Confirm patient identity, confirm procedure, confirm correct location of procedure

Social and institutional pressure

Asch, S. E. (1951). Effects of group pressure upon the modification and distortion of judgment. In H. Guetzkow (ed.) *Groups, leadership and men*. Pittsburgh, PA: Carnegie Press.
Bond, R. & Smith, P. B. (1996): Culture and Conformity: A Meta-Analysis of Studies Using Asch's (1952b, 1956) Line Judgment Task, *Psychological Bulletin, 119*(1), 111-137.



- Setup: seven people in the room, six confederates and one participant (but participant thinks everyone's a participant)
- Task: open vote on which line is the same length as reference line. 6 out of 18 trials, confederates answer correctly; 12 out of 18 trials, all confederates answer incorrectly. Participant always answers last.
- Question: will the real participant confirm to the group when the answer is so obviously wrong?